

WORLD BOOK photo

**Fossil Ferns and a Lump of Coal, left,** were both formed from the remains of plants that died many millions of years ago. While the plants lived, they stored up energy from the sun. The plants that became fossils gave up their store of energy in the process. Only the outline of their appearance remains. But the energy of the coal-forming plants is preserved in the coal. When the coal is burned, it releases this energy in the form of heat.

## COAL

**COAL** is a black or brown rock that can be ignited and burned. As coal burns, it produces energy in the form of heat. The heat from coal can be used to heat buildings and to make or process various products. But the heat is used mainly to produce electricity. Coal-burning power plants supply about half the electricity used in the United States and nearly two-thirds of that used throughout the world. Coal is also used to make *coke*, an essential raw material in the manufacture of iron and steel. Other substances obtained in the coke-making process are used to manufacture such products as drugs, dyes, and fertilizers.

Coal was once the main source of energy in all industrial countries. Coal-burning steam engines provided most of the power in these countries from the early 1800's to the early 1900's. Since the early 1900's, petroleum and natural gas have become the leading sources of energy throughout much of the world. Unlike coal, petroleum can easily be made into gasoline and the other fuels needed to run modern transportation equipment. Natural gas is often used in place of coal to provide heat. But the world's supplies of petroleum and natural gas are being used up rapidly. If they continue to be used at the present rate, they may be nearly exhausted within 75 to 100 years. The world's

supply of coal can last 300 to 400 years at the present rate of use.

Increased use of coal, especially for producing electricity, could help relieve the growing shortage of gas and oil. However, the use of coal involves certain problems. The burning of coal has been a major cause of air pollution. Methods have been developed to reduce the pollution, but these methods are costly and not yet fully effective. They must be improved before the use of coal can be increased greatly. In addition, some coal lies deep underground and so is difficult to mine.

In the past, few jobs were harder or more dangerous than that of an underground coal miner. During the 1800's, many miners had to work underground 10 or more hours a day, six days a week. Picks were almost the only equipment they had to break the coal loose. The miners used shovels to load the coal into wagons. In many cases, children as young as 10 years of age hauled the coal from the mines. Women also worked in the mines as loaders and haulers. Over the years, thousands of men, women, and children were killed in mine accidents. Thousands more died of lung diseases from breathing coal dust.

Today, machines do most of the work in coal mines. Mine safety has been improved, work hours have been shortened, and child labor is prohibited. The death rate from mine accidents in the United States has dropped dramatically since 1900. However, coal mining remains a hazardous occupation.

This article discusses how coal was formed, where it is found, its uses, and how it is mined. The article also discusses the cleaning and shipping of coal, the coal industry, and the history of the use of coal.

*Joseph W. Leonard, the contributor of this article, is Professor of Mining Engineering and Director of the Coal Research Bureau at West Virginia University. The article was critically reviewed by the National Coal Association.*

# COAL/How Coal Was Formed

Coal developed from the remains of plants that died 1 million to 440 million years ago. For this reason, it is often referred to as a *fossil fuel*. The coal-forming plants probably grew in swamps. As the plants died, they gradually formed a thick layer of matter on the swamp floor. Over the years, this matter hardened into a substance called *peat*. In time, the peat deposits became buried under sand or other mineral matter. As the mineral matter accumulated, some of it turned into such rocks as sandstone and shale. The increasing weight of the rock layers and of the other overlying materials began to change the peat into coal. Coal, sandstone, and other rocks formed from deposited materials are called *sedimentary rocks*.

The first stage in the formation of coal produces a dark brown type of coal called *lignite*. Lignite develops from buried peat deposits that have been under great pressure. The pressure results from the weight of the overlying materials and from movements within the earth's crust. As the pressure increases, lignite turns into a harder coal called *subbituminous coal*. Under greater pressure, subbituminous coal turns into a still harder coal called *bituminous coal*. Intense pressure changes bituminous coal into *anthracite*, the hardest of all coals.

Anthracites are the oldest coals in most cases, and lignites are the youngest. Some anthracites began to form as long as 440 million years ago. Some lignites developed within the last 1 million years. The greatest period of coal formation occurred about 300 million years ago, during a time in the earth's history called the *Carboniferous Period*. Swamps covered much of the earth during this period. Tall ferns and other tree-like plants grew in the swamps and produced huge amounts of peat-forming matter after they died. Today's plentiful deposits of bituminous coal developed largely from the vast peat deposits formed during the Carboniferous Period. It took about 3 to 7 feet (0.9 to 2.1 meters) of compact plant matter to produce a bed of bituminous coal 1 foot (0.3 meter) thick.

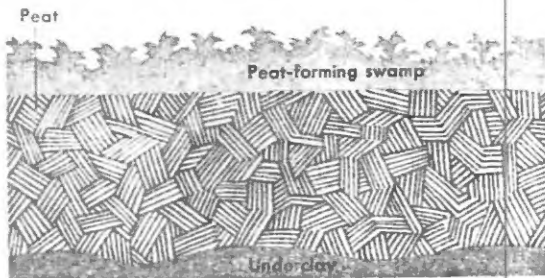
Plant materials are still accumulating in such coal-forming environments as the Everglades, the huge swamplands of southern Florida. Under the proper conditions, these materials could eventually develop into peat and then, over hundreds of thousands of years, into the various kinds of coal.

Coal beds are also called *coal seams* or *coal veins*. Present-day seams range in thickness from less than 1 inch (2.5 centimeters) to 400 feet (120 meters) or more. The thickest seams are subbituminous coals and lignites. Many coal deposits consist of two or more seams separated by layers of rocks. These formations were produced by new coal-forming swamps developing over buried ones. Each new swamp became buried and developed into a separate seam of coal.

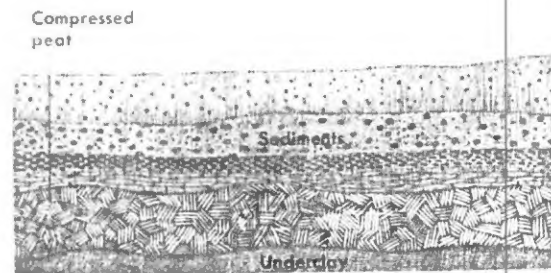
Some coal beds lie nearly parallel to the earth's surface. Other beds have been tilted by earth movements and lie at an angle to the surface. Most of the deepest beds consist of anthracites or bituminous coals. In many cases, earth movements have uplifted deep anthracite and bituminous beds to a position nearer the surface. Such movements also account for coal seams in hills and mountains.

## The Development of Coal

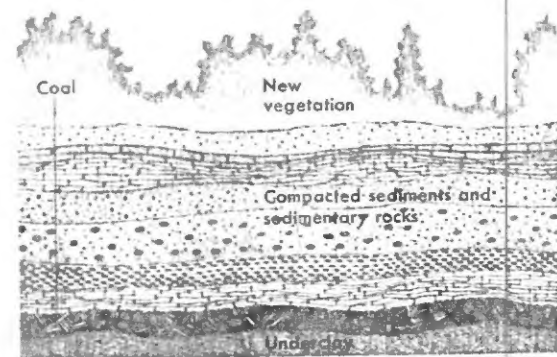
The formation of coal involved three main steps. (1) The remains of dead plants turned into a substance called *peat*. (2) The peat became buried. (3) The buried peat was subjected to great pressure. After thousands or millions of years under pressure, the peat turned into coal. Each of these steps is illustrated below.



**A Thick Layer of Peat** developed as plant matter accumulated and hardened on the floor of a swamp. The matter built up as plants that grew in the swamp died and sank to the bottom. Peat-forming swamps once covered much of the earth.



**Deposits of Loose Mineral Matter, called sediments,** completely covered the peat bed. As these sediments continued to pile up over the bed, they compressed the peat.



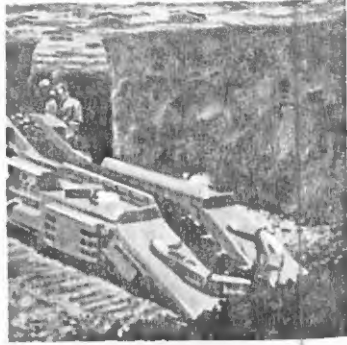
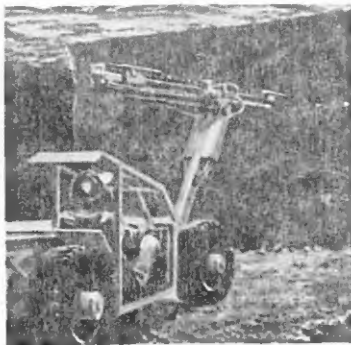
WORLD BOOK diagrams by Jean Helmer

**Pressure on the Peat** increased as the sediments became more compact and heavier. Some sediments hardened into rock. The ever-increasing weight and pressure turned the peat into coal.

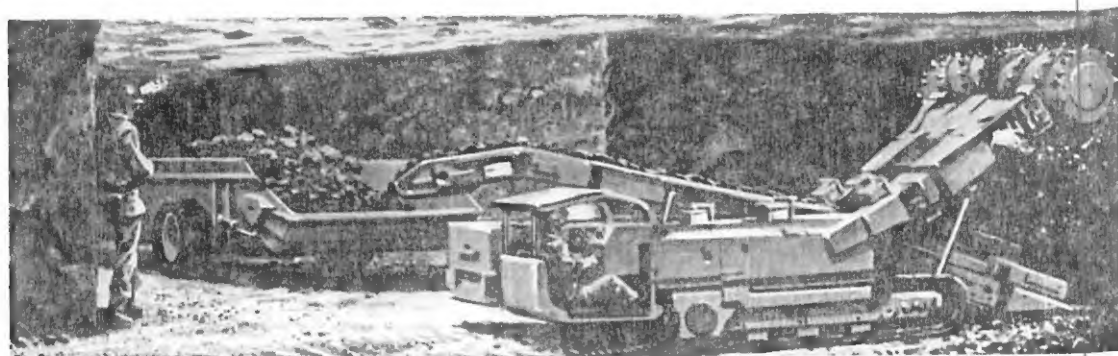
## Types of Underground-Mining Equipment

The type of equipment that an underground mine requires depends on the method of mining it uses. Mechanized mines use three main methods: (1) the conventional method, (2) continuous mining, and (3) longwall mining. Each of the three methods calls for a different type of equipment.

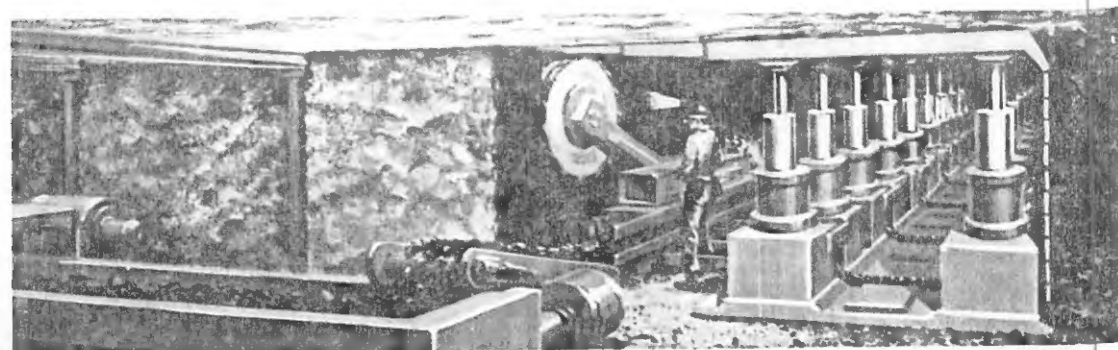
WORLD BOOK Illustrations by Robert Addison



**Conventional-Mining Equipment.** The conventional method of mining involves a series of steps, three of which require special machinery. First, a cutting machine, left, cuts a deep slit along the base of the coal face (coal exposed on the surface of a mine wall). Another machine, center, drills holes into the face. Miners load the holes with explosives and then set the explosives off. The undercutting along the bottom of the face causes the shattered coal to fall to the floor. A loading machine, right, gathers the coal onto a conveyor belt.



**Continuous-Mining Equipment** eliminates the need for separate steps in mining a face. A continuous-mining machine, right, gauges out the coal and loads it onto a shuttle car in one operation.



**Longwall-Mining Equipment.** Longwall mining differs from the other methods of underground mining in its system of roof support. The other methods are used only in room-and-pillar mines, where pillars of coal are left to support the mine roof. In the longwall method, movable steel props support the roof over one long coal face. The miners move a cutting machine back and forth across the face, shearing off coal. The coal falls onto a conveyor. As the miners advance the cutter into the bed, the roof supports are moved forward. The roof behind the miners is allowed to fall.